



U.S. DEPARTMENT OF ENERGY

**SMART**MOBILITY

Systems and Modeling for Accelerated Research in Transportation

# SMART Mobility – Advanced Fueling Infrastructure

JOHN SMART, IDAHO NATIONAL LABORATORY  
U.S. DEPARTMENT OF ENERGY  
VEHICLE TECHNOLOGIES OFFICE 2017 ANNUAL MERIT REVIEW  
April 27, 2017

INL/MIS-17-41725



# Overview

## Timeline

- Oct 1, 2016
- Sep 30, 2019
- 19% percent complete

## Budget

- AFI Pillar funding:

	FY17	Total
INL	\$360K	\$1,100K
ANL	\$210K	\$670K
LBNL	\$255K	\$770K
NREL	\$300K	\$915K
ORNL	\$285K	\$865K
PNNL	\$90K	\$180K
Total	\$1,500K	\$4,500K

## Barriers

- Infrastructure has long been a major barrier to alternative fuel vehicle (AFV) adoption
- AFV deployment for smart mobility applications has potential benefit but is dependent on cost-effective fueling infrastructure

## Partners

- DOE's SMART Mobility Laboratory Consortium
  - Core labs: ANL, INL, LBNL, NREL, ORNL
  - Supporting labs: PNNL, LANL
- INL is the lead lab for this pillar
- Labs are engaging shared mobility service providers to develop industry partnerships

*Any proposed future work is subject to change based on funding levels*

# Growth of Shared Mobility

Enabled by information technology, shared-vehicle service companies offer inexpensive, flexible, convenient personal transportation options that are rapidly growing in popularity

- Car-sharing companies had nearly 5 million members worldwide in 2014, up from 350,000 in 2006, and are projected to have over 23 million members globally by 2024<sup>1,2</sup>
- Ride-hailing company Uber took 5 years to deliver its first billion rides, but delivered its second billion in the first half of 2016 alone<sup>3</sup>

Expectations are high for shared-automated mobility in the future

- Automakers, shared-vehicle service companies, tech companies, and market analysts are all predicting disruptive market changes<sup>4,5</sup>



Source: [www.uber.com](http://www.uber.com)

1. [“Faster toward the future of mobility,”](#) Deloitte Review, issue 20, Jan 23, 2017
2. Shaheen, S., Cohen, A. (2016). Innovative mobility carsharing outlook. University of Berkeley, California
3. Solomon, B. (2016). [Uber just completed its two billionth ride.](#) Forbes. July 18, 2016
4. [“Electric, shared and autonomous vehicles will revolutionise transport in the world’s cities over the next 15 years,”](#) Bloomberg New Energy Finance and McKinsey & Company, Oct 11, 2016
5. Bliss, L., [“The Future of Autonomous Vehicles Is Shared,”](#) CityLab, Jan 6, 2017

# AFVs in Shared Mobility Applications

Companies are experimenting with AFVs (namely electric vehicles) and counting on fueling infrastructure availability



Source: [www.mavendrive.com](http://www.mavendrive.com)



Source: [localmotors.com](http://localmotors.com)



Source: [www.reachnow.com](http://www.reachnow.com)

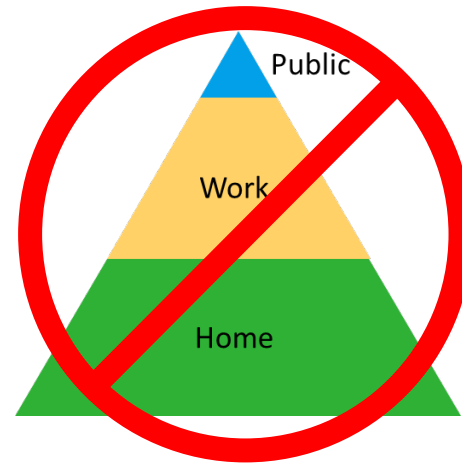
## Problem

Shared mobility and shared-automated vehicles have different operating patterns and fueling infrastructure requirements than personal-use vehicles

“San Diego’s leading car sharing company [replaced] its all-electric vehicle fleet with gas-powered cars *due to a lack of charging stations*, a symbolic setback for the emission-reduction aspirations of the city’s ballyhooed climate action plan.”<sup>1</sup>



Source: INL



1. Garrick, D., “[Car2Go switching electric cars to gas](#),” San Diego Union-Tribune, Mar 16, 2016, italics added



### Objective

We need to understand operating patterns and fueling infrastructure requirements of shared mobility in the near term and shared-automated vehicles in the future transportation system, considering:

- Unique characteristics of automated vehicles
- Shared-automated fleet management strategies
- New urban design practices
- Modal shifts and new first mile/last mile solutions
- Changing consumer preferences

DOE's SMART Mobility - Advanced Fueling Infrastructure Pillar will use the national labs' sophisticated tools and systems analysis expertise to understand the value proposition for AFVs in and fueling infrastructure needs of shared and shared-automated mobility fleets

# Outcome and Benefits

The Pillar will develop an understanding of:

- Shared mobility driving patterns
- How the value proposition and fleet energy consumption vary for different AFV technologies in near-term and mid/long-term shared mobility applications
- Requirements for fueling infrastructure in those applications



This information will provide the private sector with knowledge to make informed decisions about AFV adoption in shared mobility fleets, lowering investment risk and increasing economic stability, energy efficiency, and affordability

Image source: [www.shutterstock.com](http://www.shutterstock.com)

# Approach

The Pillar is intersecting innovative fueling infrastructure network design with emerging smart mobility trends to understand the value proposition for and market penetration of AFVs, with emphasis in the following areas:

- Near-term electrification of shared mobility
- Liquid, gaseous, and electric fueling infrastructure design concepts and analysis tools for mid/long-term shared-automated fleets
- Integration of fueling infrastructure with the built environment



Image source: [www.shutterstock.com](http://www.shutterstock.com)



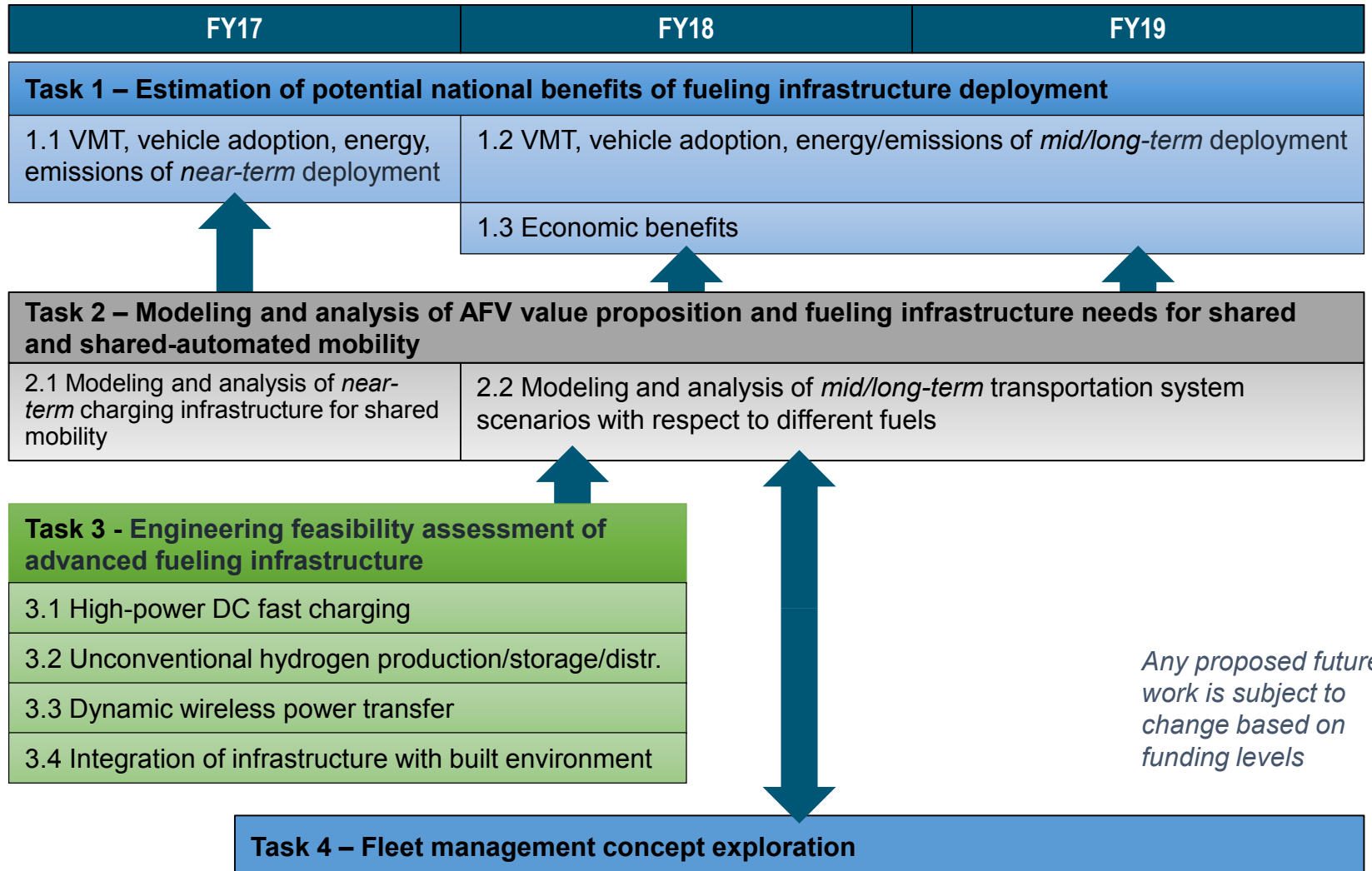
# Approach

The Pillar will accomplish this through collaborative research between six national laboratories

The labs will use existing modeling tools and develop new tools to:

1. Estimate potential national market penetration of AFVs for new mobility applications
2. Conduct focused scenario planning and cost modeling to understand AFV value proposition and fueling infrastructure requirements for shared mobility
3. Perform techno-economic feasibility assessments of emerging fueling infrastructure technology
4. Explore how fleet management may change and the impact on fueling infrastructure requirements

# Approach



## FY17 Milestones

Quarter	Milestone	
Q1	Identify geographic areas for study and external partners	Complete
Q2	Complete design of revenue/cost model framework for infrastructure deployment planning to meet the needs of both drivers and charging/fueling service providers	Complete
Q3	Establish methodology for stock-and-flow modeling of shared mobility fleet that will be used to explore different fleet management approaches	In progress
Q4	For selected regions, complete near-term plug-in electric vehicle charging infrastructure planning analysis supporting intra-city car/ride-sharing fleets	In progress

### Region Selection

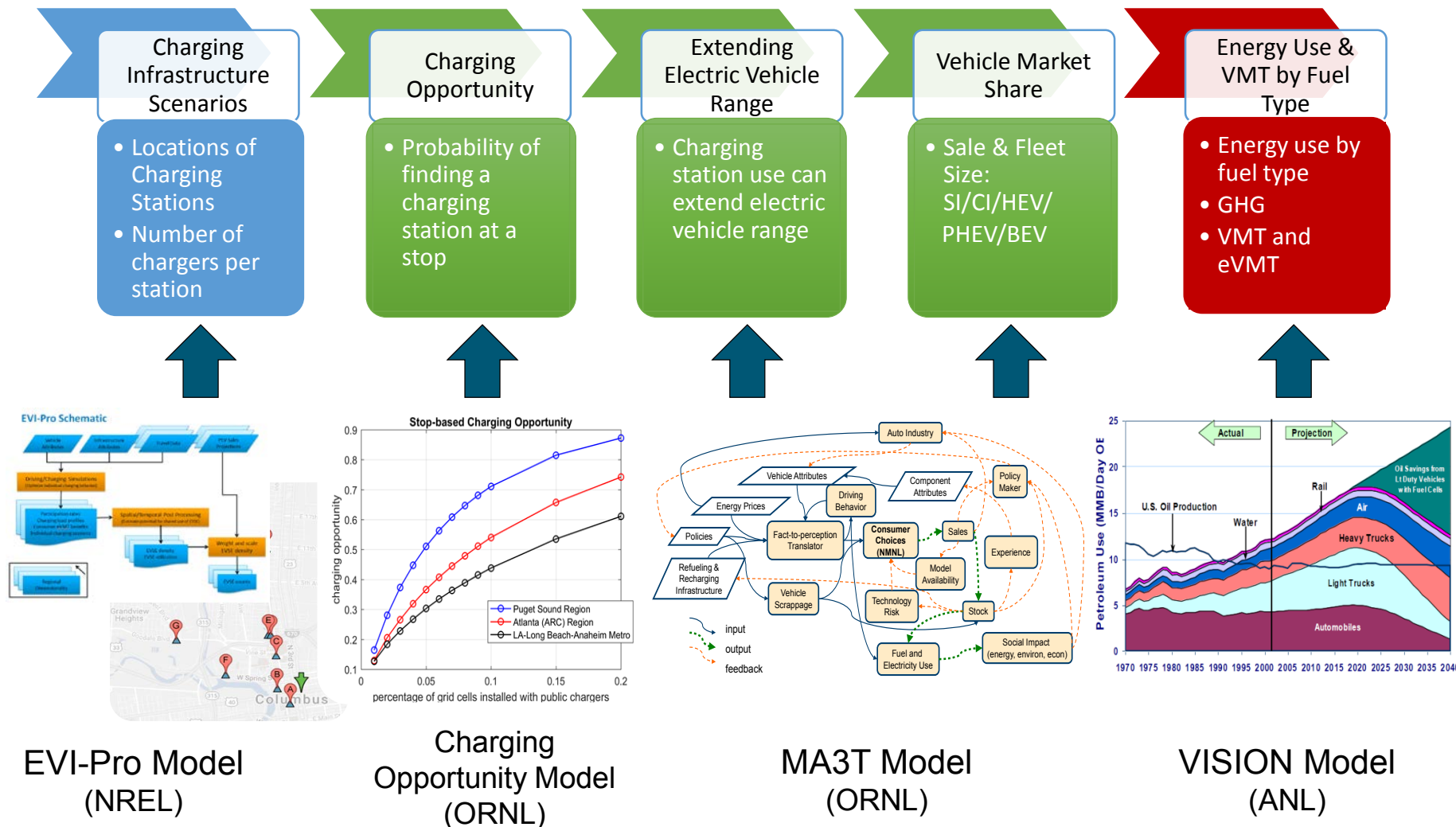
3 regions were selected for Task 2 modeling and analysis:

- Columbus, OH
- Texas Triangle (Dallas/Ft. Worth, Austin, San Antonio, and Houston metropolitan areas)
- Seattle, WA

Availability of vehicle data was the primary factor influencing region selection

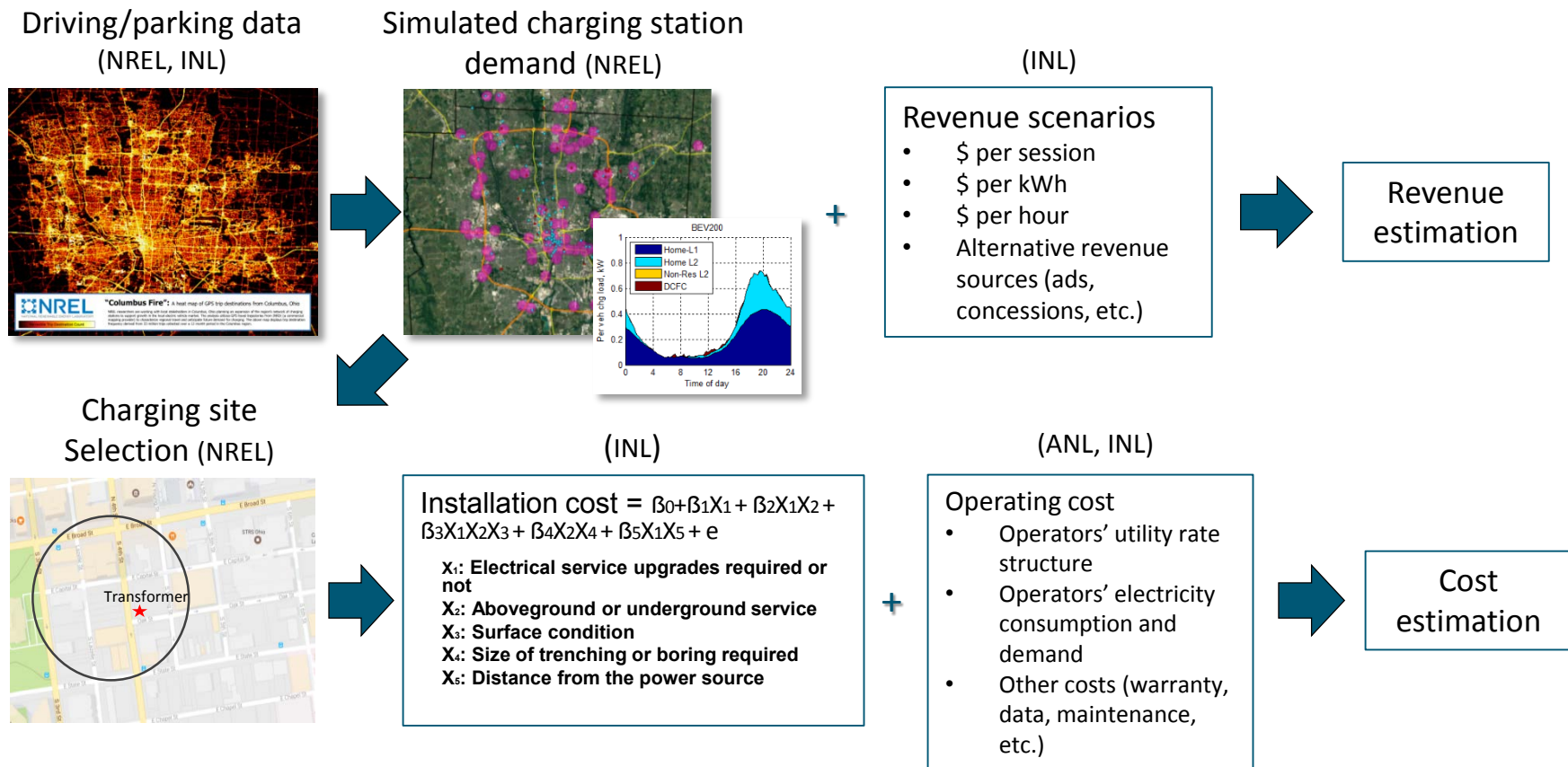
Columbus, OH was chosen because of DOE's support of the Smart Columbus project

## Task 1: Developed Approach for Analyzing Infrastructure Impacts on Electric Vehicle Market Share and Energy Use



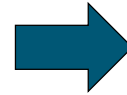


## Task 2: Developed Demand/Cost Modeling Framework for Charging Infrastructure Planning for Electric Shared Mobility

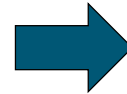


### Task 3: Established Foundation for Advanced Fueling Infrastructure Techno-economic Trade-off Analysis

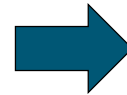
High-power DC fast charging (INL, NREL)



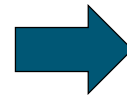
Unconventional hydrogen production /  
storage / distribution (PNNL)



Dynamic wireless power transfer (ORNL)



Integration of infrastructure with built  
environment (LBNL)



Components that drive  
cost identified through  
review of past projects  
and literature

Potential integration  
concepts identified  
through review of past  
projects and literature

# Response to Previous Year Reviewers' Comments

This pillar was not reviewed last year

# Collaboration and Coordination with Other Institutions

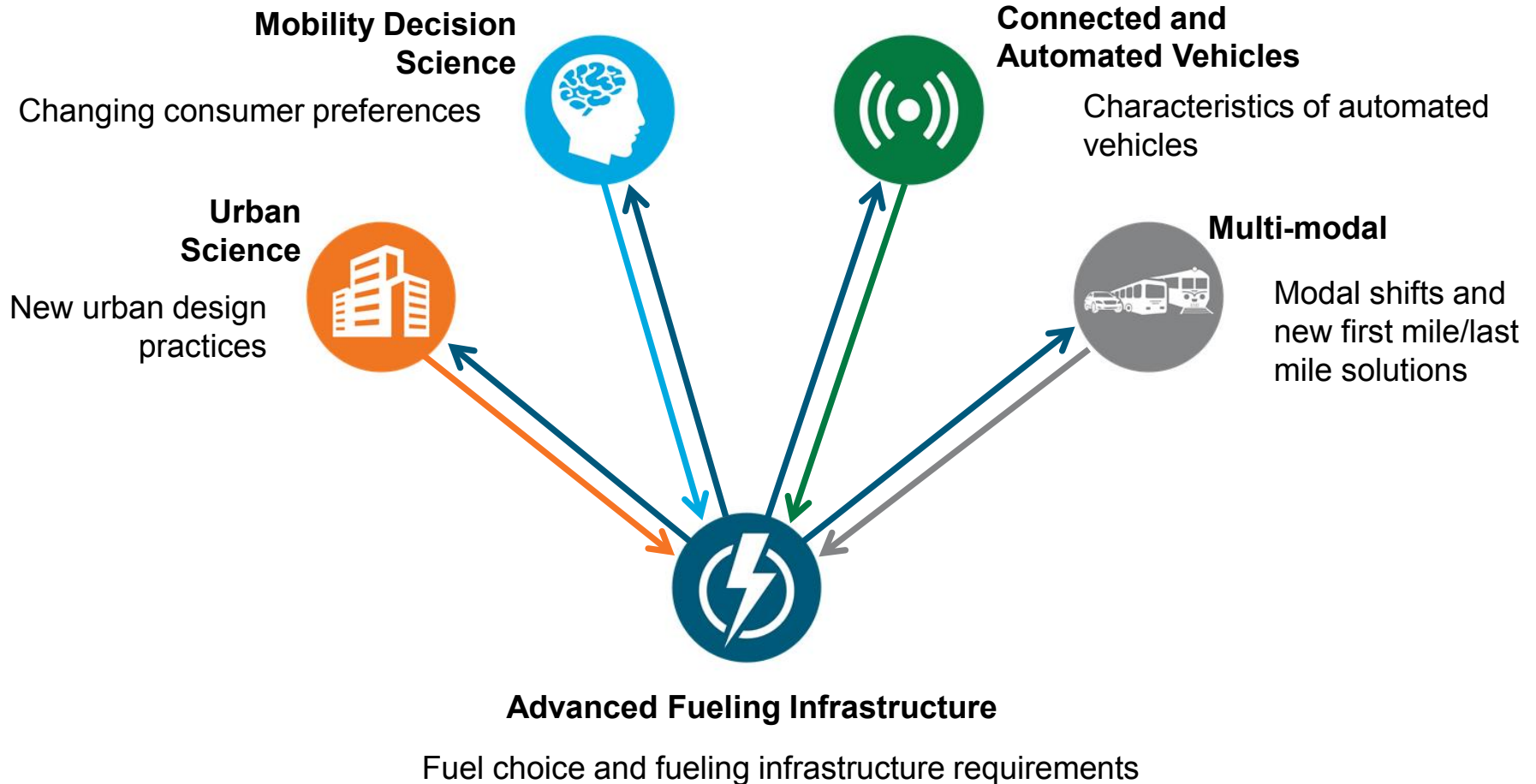
National laboratories participating in the AFI Pillar:

- ANL, INL, LBNL, NREL, ORNL, PNNL

INL is the lead lab for this pillar

Labs are engaging shared mobility and AFV fueling infrastructure service providers to develop industry partnerships (e.g. ReachNow, ChargePoint)

# Collaboration and Coordination with Other Institutions





## Remaining Challenges and Barriers / Future Research

With a modeling framework in place, the Pillar will begin the modeling and analysis necessary to identifying solutions for AFV fueling infrastructure that meet the needs of shared mobility in the future

Research will be conducted in the second half of FY17, FY18, and FY19 as outlined previously

*Any proposed future work is subject to change based on funding levels*

# Summary

- As the transportation system trends toward shared and shared-automated mobility, the value proposition of AFVs and the requirement for fueling infrastructure are also changing
- DOE's SMART Mobility - Advanced Fueling Infrastructure Pillar is researching infrastructure needs to support **electric shared mobility** in the near term and **multiple fuel options for shared-automated mobility** in the future transportation system
- Modeling frameworks have been established to model shared vehicle operating patterns, understand immediate infrastructure needs of electric shared mobility, and to assess the feasibility of new infrastructure technologies
- Further work is planned to develop mid/long-term shared-automated mobility scenarios, in coordination with the other DOE SMART Mobility Pillars
- For those scenarios, we will:
  - model the value proposition of different AFV technologies
  - develop liquid, gaseous, and electric fueling infrastructure design requirements
  - explore fleet management concepts that may impact AFV value propositions and infrastructure needs

# Questions?

**John Smart**

Idaho National Laboratory

E-mail: [John.Smart@inl.gov](mailto:John.Smart@inl.gov)

Phone: (208) 526-5922

# Technical Back-Up Slides

# Advanced Fueling Infrastructure Pillar Roadmap

